

Development of triggered scaler and its field tests in J-PARC #2

2018/6/13

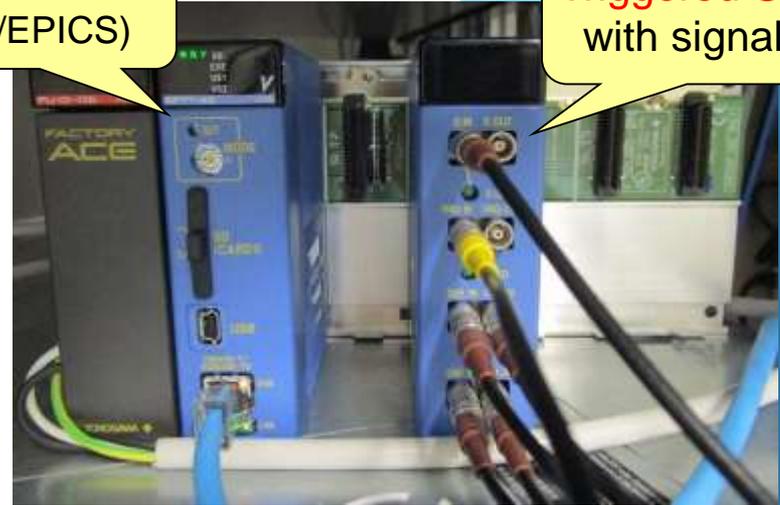
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Triggered Scaler in Field Tests

PLC-based CPU
(Linux/EPICS)

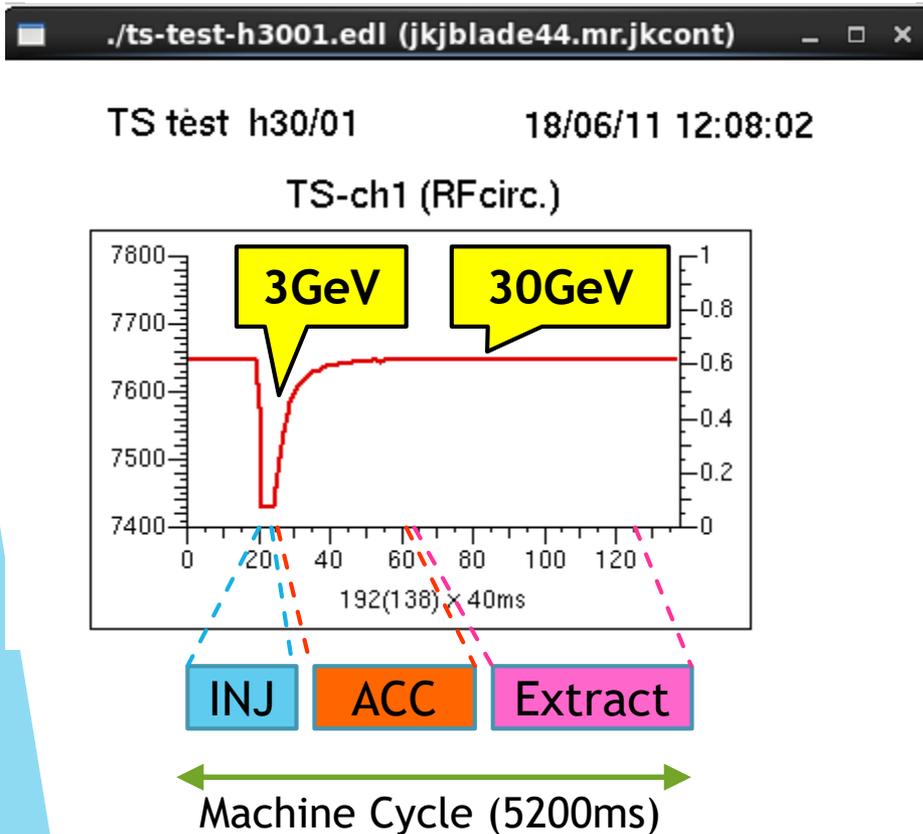
Triggered Scaler
with signals in



- ▶ As a demonstration, two accelerator signals in J-PARC MR are measured
- ▶ input Ch1: 1) RF signal (MR-ring circulation, $\sim 190\text{kHz}$), provided by LLRF
 - ▶ Calculate MR energy
- ▶ input Ch2: 2) MR abort signal, provided by MPS
 - ▶ Display MPS event to show timing in Machine Cycle

1) RF signal (MR-ring circulation)

Observed RF signal (during one Machine Cycle, 5.20s)



- ▶ Input: MR-ring circulation signal from LLRF
 - ▶ MR circumference is 1567.5m
 - ▶ Counts in a cell (40ms bin) shows that how many beam-turns go round the MR ring in 40ms
 - ▶ At 3-GeV (30-GeV), beam turns 7429 (7647) times in 40ms
- ▶ RF signal is measured successfully
 - ▶ 3->30GeV Acceleration pattern is visualized

1) RF signal (MR-ring circulation) (continued)

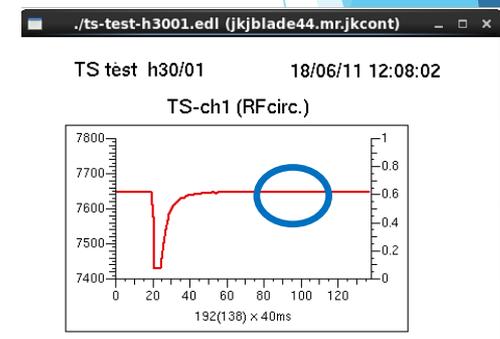
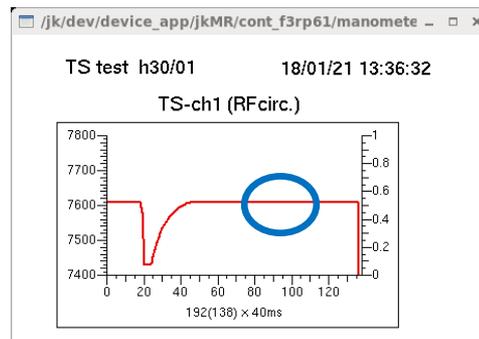
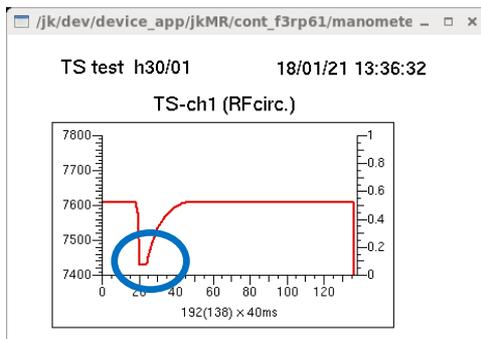
- How to calculate MR-Energy

$$\beta = \frac{v}{c} = \frac{x}{0.040} \cdot \frac{L}{c}$$

$$E = \frac{m_0 c^2}{\sqrt{1 - \beta^2}} - m_0 c^2$$

- ▶ **x** : RF signal (counts / 40 ms)
- ▶ L : Circumstance of J-PARC MR (1567.5 m)
- ▶ c : speed of light (299792458 m/s)
- ▶ β : Relative speed
- ▶ $m_0 c^2$: Proton rest mass (0.938 GeV)

- LLRF patterns (3/8GeV and 30GeV)



- Measurements by a Triggered Scaler, and calculate MR-energy

x = values measured by a Triggered Scaler

E = calculated MR energy

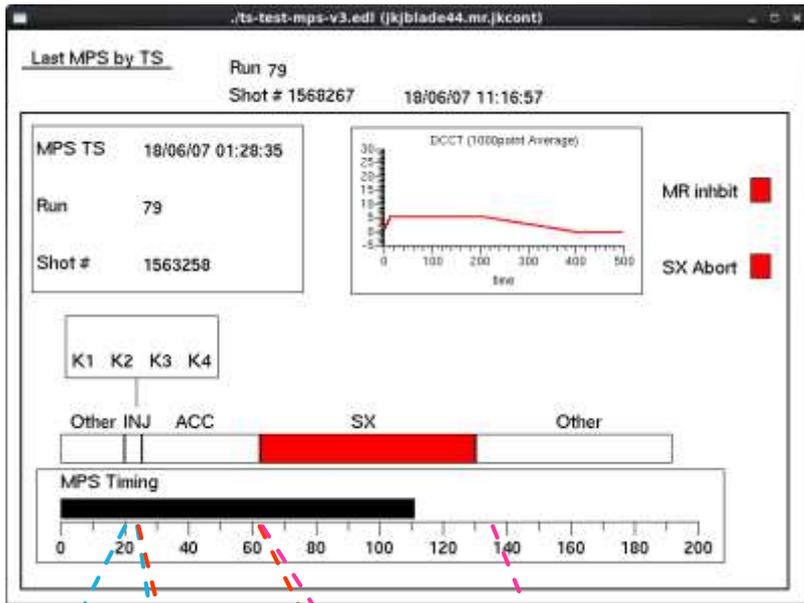
x=7429 @ 3GeV
-> E=2.991

x=7608 @ 8GeV
-> E=8.004

x=7647 @ 30GeV
-> E=31.46

2) MPS signal (MR-abort signal)

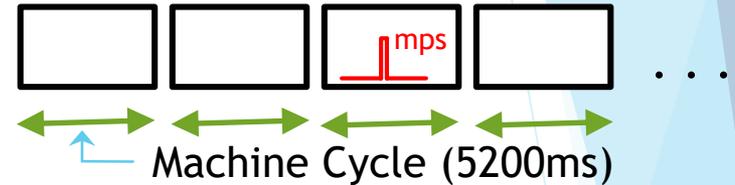
Detected MPS signal
(during Machine Cycle=5.20s)



Machine Cycle (5200ms)

MPS event happens

Input: MR-abort signal



- ▶ During stable beam operation, no signal exist (all zero)
- ▶ When a MPS event happens, count 1 appears
- ▶ Non-zero value is a start to save and show: event timestamp, RUN number, shot number, DCCT (beam current).

conclusion

- ▶ Using a new module, triggered scaler, we measured real accelerator signals (RF and MPS signals) successfully.
- ▶ The measurements demonstrated expected functionalities of the module.
- ▶ More applications, including miss-trigger detection, are planned.